A NEW METHOD FOR CALIBRATION OF HIGH-CAPACITY WIND TUNNEL FORCE MEASUREMENT INSTRUMENTS

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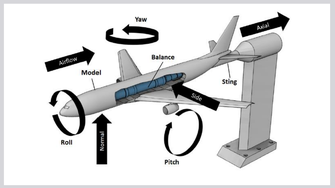
WHAT WE LEARNED

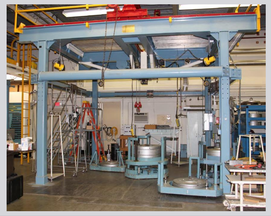
1

Instruments for measuring forces in a wind tunnel have to be calibrated.



2

Current methods employed at NASA Langley for high-capacity instruments are cumbersome.



3

We leveraged ideas from existing small-scale gravity based systems to develop a larger capacity calibration method.

BACKGROUND

NASA's premiere wind tunnels test flight vehicles with aerodynamic loads that may exceed 7000 pounds. Calibrating instruments to measure these high loads is very time consuming and expensive. Currently calibration requires stacking many large precision weights to generate loads on the force measurement instrument.

OBJECTIVES

1) A new approach is to use hydraulic power to apply loads to the sensitive side of the instrument while precisely measuring loads on the fixed side of the instrument.
2) To demonstrate the potential of this approach, two key areas are addressed:
   - A) Development of a hydraulic load application concept
   - B) Development of a precise external force and moment measurement system

METHODS

1) Mechanical design/specification of hydraulic load application
2) Matlab Code to generate all potential loads, 3 forces, 3 moments
3) Research all existing measurement methods and devices
4) Design a custom platform balance as the reference instrument

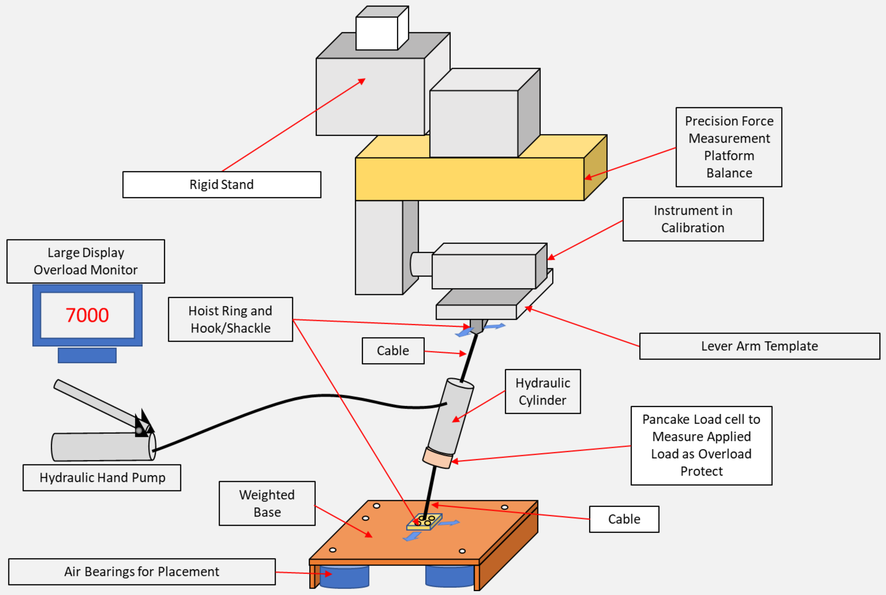
BACKGROUND

The platform balance mechanical design featured Finite Element Analysis in CREO software

- Structural steel frame designed for minimum deflection
- Flexure elements designed for a factor of safety of 1.5
- Complete 32 case load study completed and used for a virtual calibration featuring a statistical engineering approach

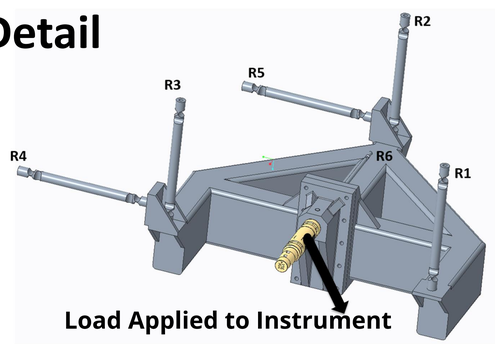
RESULTS

Overall Calibration Design Concept



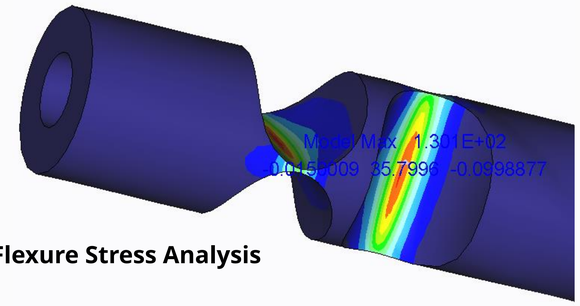
Platform Balance Detail

- Commercial load cells are located at R_1 – R_6
- Geometry allows combining components into 6 forces and moments

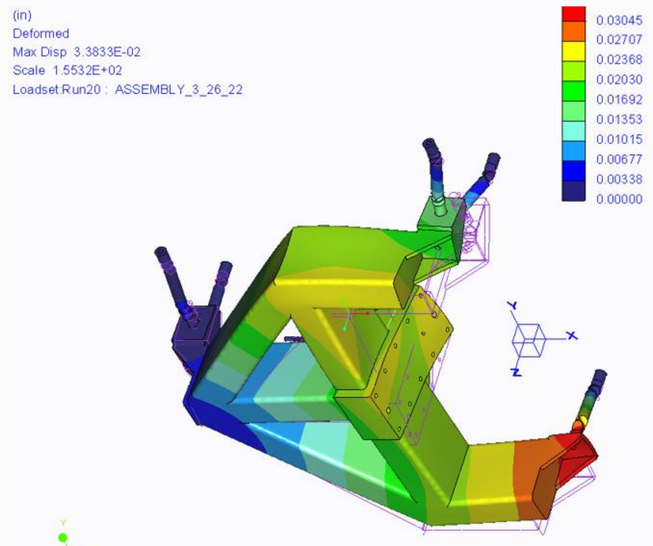


Load Applied to Instrument

Finite Element Analysis



Flexure Stress Analysis



Deflection Analysis